

CLAIMS:

1. A micro relay comprising:

5 a base substrate having an electromagnetic device, said base substrate having a fixed contact on one surface thereof;

10 an armature block including a frame secured to the surface of said base substrate, a movable plate disposed inside said frame and supported rotatably by said frame, and a movable contact base supported by said movable plate and having a movable contact, said movable plate cooperating with a magnetic material provided on a surface of said movable plate to define an armature and being driven by said electromagnetic device to switch on/off a connection between said fixed contact and said movable contact;

15 a cover bonded to said frame, said cover creating a space surrounded by said frame and closed between said base substrate and the cover to accommodate said armature and said fixed contact;

wherein

20 said base substrate has a storage recess for accommodating said electromagnetic device, said storage recess being composed of a hole extending from the one surface of said base substrate to a rear surface thereof and a thin storage recess lid fixed on the one surface of said base substrate to close said hole,

25 said electromagnetic device including a yoke, a coil wound around said yoke to generate a flux in response to an exciting current, and a permanent magnet secured to said yoke to generate a flux flowing through said armature and said yoke.

2. The micro relay as set forth in claim 1, wherein

said yoke comprises a plate-shaped cross-member and a pair of leg pieces upstanding from both ends of said cross-member,

30 said permanent magnet having a height and its opposite faces in a height direction

being magnetized to opposite poles, one pole face of said permanent magnet being secured to a longitudinal center of said cross-member between said pair of leg pieces,

5 said coil being wound around said cross-member on both sides of said permanent magnet,

top end surfaces of said leg pieces being energized to opposite poles in response to the exciting current to said coil.

3. The micro relay as set forth in claim 2, wherein

10 said cross-member has a concave portion in which said permanent magnet is put.

4. The micro relay as set forth in claim 2, wherein

 said cross-member has convex portions for preventing said coil from dropping.

15 5. The micro relay as set forth in claim 4, wherein

 said convex portions are formed at four corners on an undersurface of said cross-member.

6. The micro relay as set forth in claim 2, wherein

20 an exposed surface of said yoke and a surface of said permanent magnet are coated with resin.

7. The micro relay as set forth in claim 6, wherein

25 the top end surfaces of said leg pieces and a top end surface of said permanent magnet are polished to remove resin coating, the top end surfaces of said leg pieces and the top end surface of said permanent magnet being in a same plane.

8. The micro relay as set forth in claim 2, wherein

30 a cross-section area of each of said leg pieces is larger than that of said cross-member.

9. The micro relay as set forth in claim 1, wherein
said storage recess lid is made of a silicon layer which was formed by selectively
removing a silicon substrate and an insulating layer from a SOI substrate which
5 comprises the silicon substrate and the thin film silicon layer formed on the
insulation layer of the silicon substrate.

10. The micro relay as set forth in claim 1, wherein
said cover is closely bonded to said frame to create a sealed space surrounded by
10 said frame and closed between said base substrate and the cover,
said base substrate having a fixed contact through-hole extending from the one
surface of the base substrate to the rear surface thereof, a fixed contact electrode
formed on the rear surface of the base substrate, a fixed contact conductive layer
formed on an inner surface of said fixed contact through-hole for an electrical
15 connection between said fixed contact and said fixed contact electrode, and a thin
film through-hole lid provided on the one surface of said base substrate to close
said fixed contact through-hole.

11. The micro relay as set forth in claim 1, wherein
20 said cover is closely bonded to said frame to create a sealed space surrounded by
said frame and closed between said base substrate and the cover,
said base substrate having a fixed contact through-hole extending from the one
surface of the base substrate to the rear surface thereof, a fixed contact electrode
formed on the rear surface of the base substrate, a fixed contact conductive layer
25 formed on an inner surface of said fixed contact through-hole for an electrical
connection between said fixed contact and said fixed contact electrode, and a
metal material buried in the through-hole to close the through-hole.

12. The micro relay as set forth in claim 1, wherein
30 said base substrate has, on the one surface thereof, a wiring trace connected

electrically to said fixed contact and a ground trace connected to ground,
said wiring trace and said ground trace running in parallel in spaced relation to
each other.

5 13. The micro relay as set forth in claim 12, wherein
said cover is closely bonded to said frame to create a sealed space surrounded by
said frame and closed between said base substrate and the cover,
said base substrate having a ground through-hole extending from the one surface
of the base substrate to the rear surface thereof, a ground electrode formed on the
10 rear surface of the base substrate for earthing,
a ground conductive layer formed on an inner surface of said ground through-hole
for an electrical connection between said ground electrode and said ground trace,
and a ground through-hole closing means for closing said ground through-hole.

15 14. The micro relay as set forth in claim 1, wherein
said base substrate has two pairs of the fixed contacts at both ends in a
longitudinal direction of the base substrate,
one pair of the fixed contacts of the two pairs of the fixed contacts being grounded,
said armature having two movable contacts corresponding to the two pairs of fixed
20 contacts,
said movable contacts being connected electrically to each other through a
conductive path.

15. The micro relay as set forth in claim 1, wherein
25 said movable plate is supported by said frame through a supporting spring piece
having elastic deformability,
said movable contact base being supported by said movable plate through a
pressure spring piece,
said frame, said movable plate, said movable contact base, said supporting spring
30 piece, and said pressure spring piece being formed from one semiconductor

substrate.

16. The micro relay as set forth in claim 15, wherein
said movable plate has, on a surface facing to said base substrate, a supporting
5 protrusion at a longitudinal center of the movable plate,

an apex of said supporting protrusion being in contact with said base substrate to
allow said movable plate to make pivot motion about said apex,
said movable plate further having, on the surface facing to said base substrate,
stopper protrusions at both ends in a longitudinal direction,

10 an apex of each of said stopper protrusions coming in contact with said base
substrate to regulate pivot motion of the movable plate when said movable plate
makes the pivot motion.

17. The micro relay as set forth in claim 16, wherein

15 the apex of said supporting protrusion and the apex of each of said stopper
protrusions are in a same plane.

18. The micro relay as set forth in claim 16, wherein

the apex of said supporting protrusion, the apex of each of said stopper protrusions,
20 and an apex of said movable contact base are in a same plane.

19. The micro relay as set forth in claim 16, wherein

a distance from said supporting protrusion to said movable contact base is longer
than a distance from said supporting protrusion to a portion of said armature which
25 is attracted to said electromagnetic device.

20. The micro relay as set forth in claim 16, wherein

a distance from said supporting protrusion to said movable contact base is longer
than a distance from said supporting protrusion to each of said stopper protrusions.

21. The micro relay as set forth in claim 15, wherein
said pressure spring piece has a meandering part which meanders.
22. The micro relay as set forth in claim 1, wherein
5 said movable plate is made of a semiconductor substrate and has a hole
extending from an upper surface to a undersurface,
said magnetic material being disposed on one surface of said movable plate so
that it closes one end of said hole,
said armature block further having a second magnetic material or a metal piece,
10 said second magnetic material or said metal piece being disposed on the other
surface of said movable plate so that it closes an other end of said hole,
said magnetic material and said second magnetic material or said metal piece
being jointed to each other inside said hole by laser welding,
said movable plate being sandwiched between said magnetic material and said
15 second magnetic material or said metal piece.